

Survey

Variation in the THC Content of Illicitly Imported Cannabis* Products—1984–1989

J. E. PITTS, P. J. O'NEIL AND K. P. LEGGO

Laboratory of the Government Chemist, Teddington, London, UK and Northern Ireland

Abstract—The tetrahydrocannabinol (THC) content of more than 180 samples of fresh illicit Cannabis products, seized by H.M. Customs and Excise on entry into Great Britain and Northern Ireland over the period 1984–1989, has been determined by gas chromatography. The average THC content of herbal cannabis remained high due to good quality cannabis from Jamaica and the USA, but that of cannabis resin was slightly lower. Resin from Morocco has changed significantly in its physical appearance. There was no fresh seizure of cannabis oil in this period.

In our previous studies (Baker et al 1980a, 1982) which covered the years 1975–1978 and 1979–1981, the tetrahydrocannabinol (THC) content of illicit Cannabis products was reported. THC was determined by gas chromatography, a procedure that converts tetrahydrocannabinolic acid (THCA) to THC by decarboxylation (Fetterman et al 1971). This reaction also occurs when the Cannabis product is being smoked so the measurement of decarboxylated THCA plus the original THC gives a valid indication of potency as perceived by the user. Accordingly, in this paper THC means total THC, that is THC plus THCA. This survey covers the period 1984–1989 and reports the THC content of fresh samples of Cannabis products seized by Officers of Her Majesty's Customs and Excise (H.M.C.&E.)

Experimental

Sample selection

As in the previous papers, the country of origin of the samples was assigned by information supplied by H. M. C. & E., information from the carrier, and physical and chemical characteristics. Only fresh samples were used, that is, samples that were less than three months old on arrival. The freshness was determined by TLC (Fowler et al 1979); a sample less than three months old has significant quantities of cannabinoid acids and very little, if any, cannabinol (CBN). Before analysis samples were stored in sealed plastic boxes in the dark. Baker et al (1980b) showed that physically similar slabs of cannabis resin in a single importation have the same cannabinoid profile. Therefore a sample from a single slab is representative of the total consignment. In addition, if a large consignment was found to be composed of a number of distinct batches of cannabis resin, all fresh batches were sampled and analysed and the results are included in this survey.

Sample analysis

Two grams of material was taken from a representative

* Cannabis = *Cannabis sativa* L.; cannabis = marijuana; cannabis resin = hashish; liquid cannabis = cannabis oil or 'hash oil'.

Correspondence to: J. E. Pitts, Laboratory of the Government Chemist, Queens Road, Teddington, Middlesex TW11 0LY, UK.

sample of the original seizure. Samples were analysed as received except that main stems were excluded from herbal cannabis, and cannabis resin was ground to a powder. The cannabinoids were extracted from the sample with 20 mL methanol (ultra-sonic agitation for 20 min). This ensured complete extraction of all the cannabinoids from the samples (Baker et al 1982). The solutions of herbal cannabis and cannabis resin were filtered and diluted 1 to 25 and 1 to 50, respectively to give solutions of approx. 0.2 mg mL⁻¹. Each extract was analysed on a PU4500 gas chromatograph fitted with a 1.5 m × 4 mm i.d. glass column containing 3% OV17 on Chromosorb WHP, mesh size 100–120. The carrier gas (nitrogen) flow was 30 mL min⁻¹ and the column temperature was 245°C. A flame ionization detector was used.

Results

The total THC data content of this and our previous surveys are reported in Table 1. The THC contents of the herbal cannabis and cannabis resin seizures analysed in the current survey are given in Tables 2 and 3.

Discussion

Herbal cannabis

Between 1975 and 1981 no single country appeared to be the predominant source of fresh samples of seized cannabis. In terms of quantity seized, Nigeria and Ghana were the major sources of cannabis. Herbal cannabis from these countries was found to contain consistent levels of THC (approx. 2–4%) whereas cannabis from other countries is much more variable in its THC content.

Our previous surveys showed that in the mid-1970s herbal cannabis originating from Thailand was consistently high in THC (approx. 8% by weight), compared with the annual mean figure for THC values for all seizures which was approximately 3.5%. This finding was a scientific validation of the high illicit market value which this product (traditionally known as Thai or Buddha sticks, and consisting of flowering tops wrapped around a thin piece of bamboo and secured with twine) was alleged to command. By the late 1970s the mean content had decreased considerably; the

Table 1. Total %THC content of all fresh cannabis and cannabis resin illicitly imported into the UK 1975-1989 from known countries of origin.

Year	Number of samples	THC content (% mean \pm s.d.)
Cannabis		
1975 ^a	50	3.4 \pm 3.0
1976 ^a	50	3.8 \pm 3.5
1978 ^a	86	3.5 \pm 1.9
1979 ^a	64	3.8 \pm 2.0
1980 ^a	44	4.3 \pm 2.8
1981 ^a	41	4.9 \pm 2.6
1984	33	6.3 \pm 3.3
1985	23	4.5 \pm 4.5
1986	55	4.6 \pm 2.3
1987	24	3.5 \pm 2.3
1988	26	3.5 \pm 1.7
1989	49	4.8 \pm 2.4
Cannabis resin		
1975 ^a	11	6.8 \pm 4.8
1976 ^a	20	6.2 \pm 3.7
1978 ^a	46	7.9 \pm 4.4
1979 ^a	26	8.9 \pm 4.2
1980 ^a	8	9.4 \pm 2.0
1981 ^a	25	11.0 \pm 4.3
1984	14	11.3 \pm 5.9
1985	12	6.3 \pm 2.5
1986	14	6.2 \pm 3.7
1987	8	5.7 \pm 3.4
1988	6	7.6 \pm 0.9
1989	19	9.6 \pm 3.1

^a For full details 1975-1981 see Baker et al (1980a, 1982).

herbal material also contained much larger quantities of seeds and stem. The incidence of Thai seizures has also decreased: during the 1980s there were no seizures of the presentation in stick form, Thai cannabis invariably being intercepted as loose herbal material.

The THC content of Jamaican herbal cannabis began to increase during the period 1975-1978 although by 1981 this trend had stabilized at an average of 5% THC. The incidence of seizures of fresh Jamaican herb declined in 1980 and 1981 but, for the period covered by this report, the number of seizures has greatly increased and the quality has improved significantly. Between 1979 and 1981 herbal cannabis from the USA was seized quite frequently, albeit in small quantities, usually in postal importations. Such importations, often originating from California, invariably consisted of high quality material, both in terms of its physical form (virtually all flowering and fruiting tops) and its chemistry (high THC content). Towards the end of this period the THC content of *Cannabis* from the USA increased. This coincided with the seizure of a number of importations having the appearance of *Sinsemilla*. *Sinsemilla* is known to have a high THC content and is produced by removal of all staminate plants which increases the life of pistillate plants allowing them more time to produce THC (Clarke 1981).

From 1975 to 1981 most of the seizures of cannabis resin originated from the Lebanon, India and Pakistan, with lesser amounts coming from Morocco. During this period Lebanese resin showed a significant increase in THC content (approx. 4% THC in 1976 to approx. 9% THC in 1981). Indian and Pakistan resins were found to contain very variable amounts of THC as opposed to Moroccan resin which, although encountered less often, was found to contain consistent levels of THC.

Table 2. Total THC content (%) of cannabis illicitly imported into the UK from known countries of origin 1984-1989.

Country	Year	Mean %	Range %	s.d.	No. of samples
Antigua	1984	1.9	—	—	1
	1989	3.0	—	—	1
Ghana	1985	2.4	—	—	1
	1986	2.2	1.4-4.3	1.1	6
	1987	2.0	0.9-3.3	1.0	4
	1988	1.9	0.9-2.9	1.4	2
	1989	4.1	3.0-4.7	0.8	4
Grenada	1987	2.0	—	—	1
Guyana	1987	1.5	—	—	1
	1988	3.6	—	—	1
India	1984	8.7	—	—	1
Jamaica	1984	8.4	5.7-13.4	2.3	15
	1985	6.0	2.9-8.9	2.2	8
	1986	5.7	1.9-12.2	2.2	23
	1987	5.4	3.4-7.6	1.6	5
	1988	5.8	4.4-7.4	1.2	5
Kenya	1989	5.7	3.0-11.3	2.8	9
	1984	2.1	1.9-2.4	—	2
	1985	2.0	—	—	1
	1986	4.5	—	—	1
	1988	2.6	2.0-3.1	0.6	3
Malawi	1989	3.5	1.4-4.8	1.3	6
	1989	2.6	—	—	1
	1986	8.2	—	—	1
	1984	4.0	1.7-7.3	2.0	7
	1985	3.3	3.2-3.3	—	2
Morocco	1986	2.9	1.7-4.9	0.8	13
	1987	1.5	0.7-3.6	1.0	6
	1988	3.0	1.6-5.1	1.1	8
	1985	5.5	—	—	1
	1989	4.1	—	—	1
St. Vincent	1989	5.0	3.6-6.4	—	2
Sierra Leone	1985	0.9	—	—	1
South Africa	1985	4.0	1.1-7.3	2.2	5
	1986	4.1	2.6-6.0	1.5	4
	1987	2.7	1.4-5.2	1.7	4
	1988	2.2	1.6-2.7	0.4	4
	1989	4.6	3.3-5.5	0.7	6
Swaziland	1987	4.2	—	—	1
Thailand	1984	8.5	—	—	1
	1985	6.7	—	—	1
	1988	7.2	—	—	1
	1989	8.0	—	—	1
Trinidad	1984	8.5	—	—	1
	1988	4.0	—	—	1
	1989	4.4	2.9-6.2	1.6	4
USA	1984	7.3	2.8-12.3	4.7	3
	1985	3.5	—	—	1
	1986	6.7	3.6-9.0	2.2	5
	1987	6.4	2.2-9.0	3.6	3
	1988	4.6	—	—	1
	1989	9.4	7.0-13.4	3.5	3
Zambia	1984	2.2	—	—	1
	1985	4.0	2.7-5.3	—	2
Zimbabwe	1984	2.1	1.9-2.3	—	2
	1986	6.1	2.6-9.6	—	2
	1987	2.1	—	—	1
	1989	4.9	3.2-6.2	1.2	5

From 1975 to 1981 seizures of liquid cannabis decreased in number and, during the period covered by this survey, there were virtually no significant seizures of liquid cannabis. One, of 18 kg received in 1986, was not included in the survey as it did not appear to be fresh (i.e. it was older than 3-4 months).

As can be seen from Table 2, the high mean THC content for all fresh herbal cannabis analysed in 1984 (see Table 1) was due mainly to several samples of very good quality cannabis originating in Jamaica and the USA. The high

Table 3. Total THC content (%) of seized *Cannabis* resin illicitly imported into the UK 1984–1989.

Country	Year	Mean %	Range %	s.d.	No. of samples
Afghanistan	1985	6.4	—	—	1
India	1984	8.8	5.2–16.3	5.1	4
	1985	5.6	—	—	1
	1989	10.8	—	—	1
Iran	1985	8.8	—	—	1
Lebanon	1984	9.5	4.7–17.8	5.1	5
	1985	7.2	—	—	1
	1986	5.9	3.6–8.1	1.9	5
	1987	2.9	—	—	1
Morocco	1989	9.2	7.5–11.4	2.1	11
	1984	18.8	11.7–26.0	—	2
	1985	4.5	0.9–6.6	3.1	3
	1986	6.6	0.5–10.1	3.3	6
	1987	5.4	1.1–11.2	5.0	4
Pakistan	1988	8.0	6.8–8.9	0.8	4
	1989	13.1	11.0–15.0	1.5	6
	1984	12.7	10.6–14.8	2.1	3
	1985	6.8	2.4–9.9	2.8	5
	1986	6.0	1.1–14.6	7.5	3
	1987	6.5	5.1–7.9	1.4	3
	1988	6.9	6.2–7.5	—	2
	1989	5.9	—	—	1

mean THC content of cannabis resin seen in 1984 was due to good quality material from India, Pakistan and the Lebanon; in 1981 it was due to samples of good quality from India.

Unlike previous surveys, when no one country was the source of a significant proportion of the seizures, in this survey most of the fresh samples of herbal cannabis seized have come from Jamaica and Nigeria. Fresh resin seized has come from all three main producing countries; from 1984 to 1986 samples from The Lebanon were frequent but from 1986 to 1989 Morocco and Pakistan became the major supplying countries. This, however, does not necessarily relate to the overall weight of *Cannabis* products seized.

From Table 2 it is apparent that Thai cannabis has been seen only rarely; it has consisted of large (25–40 cm) stems containing a high proportion of seeds, but it has remained of above average quality. It has not been encountered as “Buddha” sticks in this laboratory for several years.

There have been frequent seizures of high quality Jamaican cannabis and the physical appearance has changed since the mid 1970s (Baker et al 1980c). It was previously seen as brown and very coarse herbal material with a high proportion of stems and seeds. Nowadays it varies from green to green/brown in colour and is presented either as loose herb or compressed blocks (or compressed to fit the shape of its intended concealment). It has a distinctive, characteristic odour; its physical appearance has improved; and its THC content has increased greatly in the years 1976–1989.

It is assumed that all seizures are of material grown in the island of Jamaica because the export route began there; it is possible, however, that the material of some seizures was grown in one of the adjacent islands of the West Indies. Certain seizures, from information supplied by the carrier, can be definitely attributed to other source islands, e.g. St Lucia. The material from these other islands is physically and chemically very similar to that grown in Jamaica.

In addition to herbal cannabis, a different product known to originate in Jamaica has been seen. The material has the

appearance of a roughly made resinous-type of material but the cannabinoid profile is the same as that of Jamaican cannabis. It is unlikely that any significant quantity, if any, of cannabis resin could be physically extracted from plants grown in Jamaica or the West Indies as the rainfall in this area is too high to allow the plants to produce extractable quantities of resin. Resin production remains located within the “cannabis resin belt” stretching from Morocco through the Middle-east to the northern part of the Indian subcontinent. In the “resin” from Jamaica, however, all macroscopic herbal characteristics have been destroyed: microscopically it has no features that suggest it to be made from either herbal cannabis or cannabis resin. It is not sticky, odorous, or pliable in the way that, for example, cannabis resin from Pakistan is. Although it has the same cannabinoid profile as herb from Jamaica, the actual level of cannabinoids varies greatly (i.e. the THC content can be from less than 1% to greater than 5% by weight). It is not known exactly how it is made: one explanation is that after the best of the herbal cannabis has been harvested the residue is processed to give a material that could be mistaken for cannabis resin. This treatment may involve the herbal cannabis being chopped and compressed into blocks, possibly with water being present to assist the processing. Such a product would probably have a higher illicit market value than low quality herb. In the UK it has been colloquially referred to as “Jamaican Black”.

Ghana and Nigeria—the major sources for the UK—continue to grow cannabis that is consistent both chemically and physically: it contains 2–3% THC, in compressed blocks of coarsely chopped brown/green coloured herbal material, with Nigerian cannabis notably including small twisted stems and a high proportion of dark seeds. There is some evidence that a change in the cultivation of cannabis in Nigeria occurred in late 1988. Some samples have been examined in this laboratory that have been greener, more finely chopped than previously seen and the THC content of these samples is between 5% and 7% by weight. There is some evidence of a similar change in Ghanaian herbal cannabis, but it is too soon to tell if this is a definite trend.

Herbal cannabis originating in the USA is seen quite frequently and is usually of high quality (>6% THC). There continues to be occasional seizures of *Sinsemilla*. There is one notable distinction between cannabis from the USA and the other countries included in this survey. Most cannabis has been found to have a cannabidiol (CBD) content not exceeding 0.3% whereas cannabis from the USA is frequently seen containing between 0.3 and 0.5% CBD; one sample contained 1.1% CBD. (The exception to cannabis having not more than 0.3% CBD is the infrequent cannabis seizures from traditionally resin producing areas. Such herbal cannabis often contains a CBD content comparable to the resin produced in the same country. In recent years, herbal seizures from the countries of the “resin belt” have been very rare.)

Herbal cannabis from South Africa is still seen, although rarely in its traditional presentation of “Durban sticks” (Small rolls of herbal cannabis wrapped in brown paper). Recent seizures have been of loose herb or compressed blocks, the herb usually being dark green and having a THC content of approximately 4%.

The significant feature of herb from south east African countries, i.e. Kenya and Zimbabwe is the high level of THV. From thin layer chromatography (Fowler et al 1979) the THV:THC ratio approaches 1:1. The only other country that produces herbal cannabis with this characteristic is India, but this is chemically distinguishable from south east African cannabis by the presence of CBD.

Cannabis resin

Cannabis resin seizures have also shown distinct patterns. Resins from both India and Nepal ("Temple Balls") are only rarely seen, and then only in small (<2 kg) quantities. Lebanese resin ("Lebanese Gold") was very abundant from 1984 to 1986 but the frequency of seizures of this resin declined during 1987 and 1988. Towards the end of 1989 however, there was one major seizure of Lebanese resin. Analysis showed that it consisted of several batches of resin not as fresh as that usually included in these surveys. The THC content varied from 6.2 to 10.3% and the cannabinol (CBN) content varied from 0.6 to 1.8%. The CBD percentage content was approximately twice that of THC. The presentation of powder compressed resin slabs wrapped in white, or occasionally coloured, cloth remains unchanged.

The major change in presentation of cannabis resin has occurred in the product from Morocco. It always used to be seen as yellow/brown powdery compressed thin slabs of resin wrapped in clear plastic (or clear plastic bearing a coloured design) bound with clear adhesive tape. The weight was often 100 g per slab and occasionally there was an imprint of a coin in one side. This form is now rarely seen, the current presentations being either "soap bars" or "rectangular bars" (United Nations 1987). These "soap bars" or "rectangular bars" consist of compressed cannabis resin wrapped in clear plastic (Cellophane which never bears a coloured design, unlike a proportion of the Cellophane found around the "old-style" presentation) and clear adhesive tape. The surface of these resin "bars" is dark brown and shiny; the inside is yellow/brown or dark green and is soft when fresh. The cannabinoid pattern remains the same as previously—its significant feature being that the CBD content is approximately 50% that of THC. The "bars" have so far been seen in 250 or 100 g sizes, sometimes with a design or a coin imprint on one surface. Seizures of resin from the third major producing area, Pakistan/Afghanistan, had declined in frequency during the early 1980s. Towards the end of 1987 however, there were several significant seizures of resin from this region. Many of these seizures were not fresh enough to be included in this survey. When it is encountered its presentation is unchanged. The surface of the resin is dark, shiny brown; inside it is brown and soft when fresh. It is usually wrapped in plastic and is in prepared 500 g or 1 kg slabs. This may be distinguished chemically from Moroccan and Lebanese resins; the THC:CBD ratio for fresh Moroccan, Pakistan and Lebanese resins being approximately 2:1, 1:1 and 1:2, respectively.

Unlike in our previous surveys, no one country supplied the major proportion of seizures of fresh cannabis resin. From 1984 to 1986 fresh samples from the Lebanon predominated, to be superseded from 1986 to 1989 by those from Morocco. During the early part of this survey the THC content of Lebanese resin was consistently higher than that

of resin from any other country but this has declined along with the frequency of seizures.

Moroccan resin samples have generally had a THC content of greater than 6% but the resin seized in 1989 showed a big increase in THC content to 13.9%. Several seizures however, have been seen with a THC content of less than 1%. Previously, low THC content in Moroccan samples could be explained by the well documented and long-standing practice of adulteration of Moroccan resin with henna powder. Several seizures, however, in 1987 and 1988 have been seen where the resin has been adulterated with a wax.

The THC content of resin samples from Afghanistan and Pakistan is very variable. This is probably due to three major factors:

(a) Lebanese and Moroccan cannabis resin is produced by a quicker and more mechanical way (threshing) than the resins from Afghanistan and Pakistan (rubbing and kneading). The resin in Afghanistan and Pakistan is often stored for a number of months during its production (Chopra 1957) whereas Lebanese and Moroccan cannabis resin is soon available for sale.

(b) In Lebanon and Morocco the resin producing areas are nearer to centres of population and the ports and airports; in Afghanistan and Pakistan the resin is produced at a considerable distance from the embarkation ports. Furthermore the importation routes into Europe from the Lebanon and Morocco are much shorter than those from Afghanistan and Pakistan.

(c) The traditional hoarding of multi-ton stocks in Afghanistan and Pakistan accounts for many seizures of material approximately 12 to 18 months old at importation.

Acknowledgements

The authors thank Suzanne Bunn, Peter Cain, Nick Fahie-Wilson, Margaret Harte, William Morgan, Nicola Trenaman and John Willer for their help in the practical work.

References

- Baker, P. B., Bagon, K. R., Gough, T. A. (1980a) Variation in the THC content in illicitly imported Cannabis products. *Bulletin on Narcotics* (United Nations publication) 32: 47-54
- Baker, P. B., Fowler, R., Bagon, K. R., Gough, T. A. (1980b) Determination of the distribution of cannabinoids in Cannabis resin using high performance liquid chromatography. *J. Analyt. Toxicol.* 4: 145-152
- Baker, P. B., Gough, T. A., Taylor, B. J. (1980c) Illicitly imported Cannabis products: some physical and chemical features indicative of their origin. *Bulletin on Narcotics* (United Nations publication) 32: 31-40
- Baker, P. B., Gough, T. A., Johncock, S. I. M., Taylor, B. J., Wyles, L. T. (1982) Variation in the THC content in illicitly imported Cannabis products Part II. *Ibid.* 34: 101-108
- Chopra, I. C. (1957) The use of the Cannabis drugs in India. *Ibid.* 9: 4-29
- Clarke, R. C. (1981) *Marijuana Botany: An Advanced Study: The Propagation and Breeding of Distinctive Cannabis*. (Berkeley, California, And/Or Press)
- Fetterman, P. S., Doorenbos, N. J., Keith, E. S., Quimby, M. W. (1971) A simple gas liquid chromatography procedure for determination of cannabinoidic acids in *Cannabis sativa* L. *Experientia* 27: 988-990
- Fowler, R., Gilhooley, R. A., Baker P. B. (1979) Thin layer chromatography of cannabinoids. *J. Chromatog.* 171: 509-511
- United Nations publication (1987) "Recommended Methods for Testing Cannabis".